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## THE AVIFAUNA OF SOKOKE FOREST, KENYA

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### INTRODUCTION

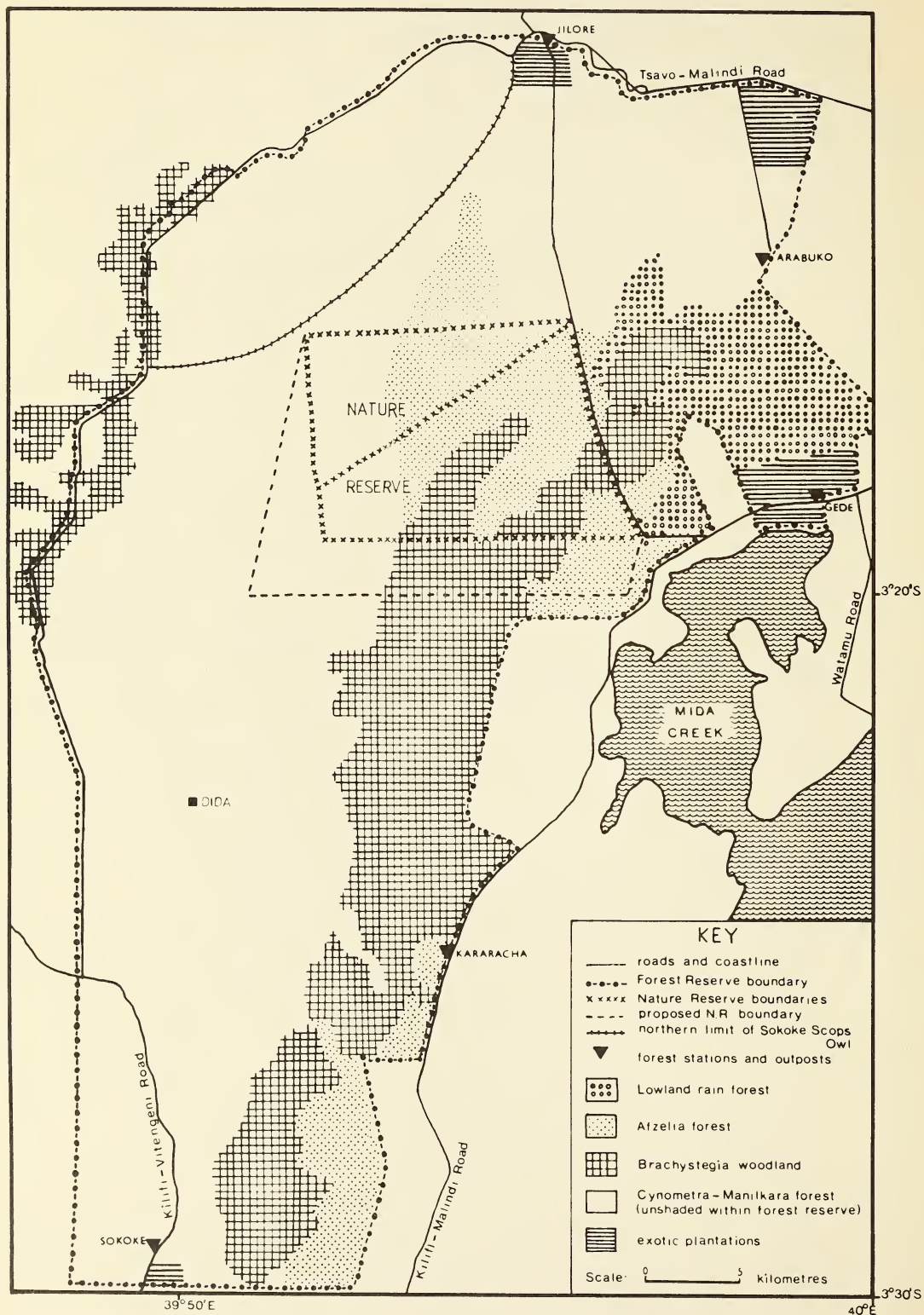
The Sokoke (or Arabuko-Sokoke) Forest, situated just inland from the Kenya coast, between Kilifi Creek and the Galana River, is one of East Africa's few surviving areas of lowland forest of any appreciable size. In Ripley & Bond (1971), A.D. Forbes-Watson stated that 'about half of the Sokoke Forest has been destroyed by man in the last ten years', and that all the areas in which he collected birds in 1964-66 'are now no longer forest, but desolate areas of sandy soil and straggly crops' Based on extensive ground coverage and a flight over the forest, Britton (1975) reported that most of the 400 km<sup>2</sup> forest reserve was still intact. Areas referred to by Forbes-Watson are south and east of the gazetted forest reserve; similar areas to the west continue to be cut and settled, and must be disregarded in any long term evaluation of the status of forest birds.

The interesting avifauna of Sokoke Forest has been documented by Ripley & Bond (1971), and there are notes on selected species by Williams (1957), Clancey & Williams (1959), Ripley (1966), Britton & Britton (1977, 1978) and Britton & Rathbun (1978). Including species flying over the forest or living along its borders, Ripley & Bond (1971) listed 173 species, apparently regarding the forest as a uniform biome despite the vegetative differences which they mention. In the main the data incorporated were obtained in the southern part of Sokoke Forest near Kilifi, in areas which are no longer forested. Some of the early specimen records which they include are unlikely to refer to Sokoke Forest even if labelled Sokoke—the name 'Arabuko-Sokoke' is derived from villages at Arabuko and Sokoke respectively at the northern and southern extremities of the forest reserve.

DAZ first visited Sokoke Forest in August 1963 when he made general observations and collected selectively south of the forest reserve, returning in July 1966 to census bird populations in the same area. With Lawrence Binford he spent one week in the forest in October 1973, mainly near Kararacha; and in June 1977 and June 1978 he visited various sites in the forest with Marion Zimmerman. As a resident of Mombasa since 1973, PLB has spent numerous weekends and longer periods studying the birds of this forest, often assisted by his wife Hazel. Particular emphasis has been given to evaluating the status of threatened species, especially endemics, as part of a more general study of the bird of each habitat, and of the extent and condition of each habitat. The present paper is an attempt to collate existing information on the avifauna of each of the plant associations of Sokoke Forest. Seasonality will be dealt with elsewhere.

### VEGETATION

Four forest habitats are distinguished and mapped in Figure 1, though one of these is more properly described as woodland, and the others are often of a relatively scrubby type. In his extensive discussion of African lowland forests and their birds, Moreau (1966) referred to 'the vestigial coastal forests of East Africa' as a 'coastal forest-savanna mosaic', and singled out Sokoke Forest and Pugu Hills Forest as most important.





Nomenclature of vegetation is that used in A Numbered (Checklist of Trees, Shrubs and Noteworthy Lianas Indigenous to Kenya, 1970, by J.B. Gillett & P.G.M. McDonald.

More than half (220 km<sup>2</sup>) of the forest reserve at Sokoke is above the 60 m contour on magarini sand soils. The closed canopy evergreen forest occupying these extremely infertile dark red loams is termed *Cynometra-Manilkara* forest by Moomaw (1960). Over a distance of less than 20 km, this habitat changes from rich forest over 15 m high in the south to impoverished thicket (4 m or lower) in the comparatively arid northwest. *Cynometra webberi*, *Manilkara sulcata* and *Brachylaena hutchinsii* are dominant throughout; the last was probably the most conspicuous tree species in undisturbed stands, reaching a height of 20 m or more. Smaller trees include species of *Pavetta*, *Cremaspora* and *Canthium*. Cycads *Encephalartos hildebrandtii* are numerous and very impressive in higher rainfall areas, and their virtual absence from northern areas of low rainfall west of Jilore is noteworthy. The understory of tangled saplings and lianas, extending from near ground level to the canopy, is of variable density, thinnest in the tallest stands. The heavy red soil beneath the moderate leaf litter holds water well.

Eighteen per cent (70 km<sup>2</sup>) of the forest reserve is occupied by open woodland dominated by *Brachystegia spiciformis* trees up to 18 m high. *Brachystegia* (or miombo) woodland is one of Africa's important vegetation types. It is a habitat of high avian endemism (Benson & Irwin 1966) and dominates southern Africa between 5° and 17°S (Moreau 1966). Only this one species ranges into Kenya, in scattered remnants north to Marafa and Hadu (Moomaw 1960). *Brachystegia* woodland in Kenya is not usually regarded as part of the main *Brachystegia* belt (Keay 1959), and it supports a comparatively impoverished avifauna. Moomaw (1960) and others have considered this and the next vegetation type together. We regard them as clearly defined, both floristically and structurally, though they frequently merge.

In Sokoke Forest, *Brachystegia* occupies deep, loose, light grey to buff, medium to coarse sands; according to Moomaw (1960) 'these soils are about as poor a prospect for agricultural development as any on the coast and are rarely cultivated'. Rainfall ranges from 600 to 1000 mm per annum, and in most situations there is evidence of ground water at depth for part of the dry season, especially along the western boundary of the forest reserve where rainfall is lowest. The overwhelming dominance of *B. spiciformis* is well illustrated by Table 7 in Moomaw (1960), where 71 out of 99 trees are this species, at a mean distance of 16.4 m apart. The canopy has a coverage rarely exceeding 50%. Adequate sunlight permits a diverse shrub layer to develop. This occurs in patches or thickets which may be quite dense, and includes numerous cycads. Ground cover is of varying density, including areas of knee-high grasses, though the sandy substrate permits rapid percolation, leaving little water in the soil to promote plant growth. Demarcation between these light soils and the heavier magarini sands is usually very abrupt, typically in the form of a drainage line with seasonal pools. Here the woodland is particularly open, often including Baobabs *Adansonia digitata*.

Thirteen per cent (50 km<sup>2</sup>) of the forest reserve is occupied by a considerably more dense, generally evergreen, forest characterised by *Azelia cuanzensis*, *Trachylobium verrucosum* and *Julbernardia magnistipulata*. The nearly continuous canopy is as low as 10-12 m. With its tangled understory of shrubs and small trees, and moderate leaf litter, it is structurally similar to parts of the *Cynometra-Manilkara* forest. This distinct vegetation type occupies areas of more compact buff-grey sands receiving less than 1000 mm of rainfall.

The final vegetation type is lowland rain forest, which replaces *Azelia* forest in areas of higher rainfall (more than 1000 mm per annum) on similar soils. The small area (less than 20 km<sup>2</sup>) remaining under this habitat is close to Gede Forest Station, and is referred to as the Mida-Gede forest by Moomaw (1960). It continues to be systematically destroyed. Apart from a higher canopy and a less tangled understory it is structurally similar to *Azelia* forest. The composition of this remnant habitat differs from stand to stand in coastal Kenya; Moomaw (1960) has grouped them together using the term *Sterculia-Chlorophora/Memecylon* forest. Early logging of valuable trees like *Sterculia appendiculata* has resulted in a modified composition. At Mida-Gede, characteristic trees include *Combretum schumannii*, *Sorindeia obtusifoliolata*, *Lannea stuhlmanni*, *Lecaniodiscus fraxinifolius* and species of *Diosypros*.

Having depleted the forest reserve of valuable timber, the sawmills at Arabuko, Dida and Kararacha ceased operations long ago. Natural regeneration has not occurred. Evidently Muhuhu *Brachylaena hutchinsii* was regarded as less valuable in the past than it is now (mainly for carvings), as one

still sees scores or hundreds of trees awaiting collection at Dida and Kararacha as well as smaller stacks throughout the *Cynometra-Manilkara* forest. There is no evidence that other species have been systematically logged in recent years, though felled trees are an increasingly common sight in all forest habitats, often involving great wastage. All four habitats continue to be modified by the cutting of saplings and small trees for use as poles in the building industry. No cutting is allowed in the 43 km<sup>2</sup> nature reserve established by the Forestry Department of the Ministry of Natural Resources. Figure 1 shows that the nature reserve occupies an area of diverse soils and vegetation types. In an unpublished report to the Office of the President, Britton, Gerhart, Risley & Turner (1977) suggested that the nature reserve be enlarged to 60 km<sup>2</sup>, and that at least 200 km<sup>2</sup> of forest reserve surrounding the nature reserve should be set aside for continued traditional utilization (see Figure 1).

Within the forest reserve, plantations of exotic trees are confined to the near vicinity of forest stations and outposts. Indigenous forest continues to be destroyed to make way for these expanding plantations, especially in the vicinity of the forest stations at Gede and Jilore. The whole area to the east of the Mida-Jilore track is potentially threatened, especially high rainfall areas occupied by lowland rain forest. Within the forest reserve this beautiful habitat might eventually survive as a mere strip beside the Mombasa-Malindi road, though the remnant on coral rag at the nearby 44 ha Gede Historical Monument has a reasonably secure future.

### THE AVIFAUNA

We include 142 species in the avifauna of Sokoke Forest (Table 1). Our somewhat unsatisfactory categories A, B, C or D should be regarded as indicators of relative abundance. A 'visit' is a night camped in one of these four vegetation types, involving an evening and morning of field work (aided by mist-nets). Variation within a habitat renders some allocations arbitrary, for example the Four-coloured Bush Shrike *Malaconotus quadricolor* which is common in some areas of *Cynometra-Manilkara* forest yet absent from taller stands. We have excluded species known to occur within the forest reserve in habitats other than the four listed; notably the open woodland and seasonal pools along the drainage line separating magarini sands from lighter soils, and the small areas of open bushland along the boundary road west of Jilore. Aerial-feeding bee-eaters, swifts and hirundines are excluded unless they have been seen perched or flying below the canopy. In particular Palm Swifts *Cypsiurus parvus* are regularly seen above the canopy, though there are no likely nesting sites within the forest reserve. Overflying raptors are excluded unless they have been seen perched; and to include overflying Open-bill Storks *Anastomus lamelligerus*, Madagascar Pratincoles *Glareola ocularis*, Green Sandpipers *Tringa ochropus*, or other transient non-forest species, would render Table 1 rather meaningless as a list of forest birds. Migrant Dwarf Bittern *Ixobrychus sturmii* and Grey Wagtail *Motacilla cinerea* on the ground in atypical habitat have been similarly excluded. We realise that inclusion or exclusion of some species is arbitrary; in cases of doubt these are excluded.

Of 142 species listed in Table 1, only 64, 70 and 79 occur in forest habitats 1, 4 and 2 respectively (cf. 133 species in *Brachystegia* woodland). Considering only those 63 species which we regard as primarily forest or *Brachystegia* woodland birds in coastal Kenya, 42, 42 or 49 occur in forest habitats, and 57 occur in *Brachystegia*. Census results are given in Table 2. Indices of species diversity for these four habitats, and for other African forest habitats, are given in Table 3. These are derived from birds caught in mist-nets within 2.5 m of the ground, and are referable to the forest or woodland understory. Indices range from 2.59 (or 0.876) in *Brachystegia* woodland to 2.81 (or 0.921) in *Cynometra-Manilkara* forest; indices for the other two habitats are very similar, with different ranking by different methods. The composition of ten bird parties is detailed in Table 4.

Using the density estimate methods of MacArthur, Diamond & Karr (1972) for four day periods in August 1973, PLB attempted to assess the relative density of understory birds in *Afzelia* and *Cynometra-Manilkara* forest. Under identical conditions, using 140 m of net in a single line for 13 hours daily, he caught 76 birds of 17 species (biomass 1793 g) in *Afzelia* and 74 birds of 20 species (biomass 2256 g) in *Cynometra-Manilkara*, giving theoretical foraging populations of 96 and 84 birds respectively. On average, birds in the understory of *Cynometra-Manilkara* are larger than in the structurally similar *Afzelia* forest, so that the theoretical biomass is 13% greater even though the number of individuals is fewer. Counts of individuals in 2 ha tracts of *Cynometra-Manilkara* forest and *Brachystegia* woodland, using visual, aural and netting methods in all vegetation strata, were 135 (35 species) and 82 (32 species) respectively (Table 2).



TABLE 1

*Birds recorded in the four major habitat types of Sokoke Forest.*

Notes: 1=Lowland rain forest; 2=*Afzelia*; 3=*Brachystegia*;

4=*Cynometra*. The four indicators of status are:

A, characteristic species, recorded on more than 90% of visits;

B, recorded on 50–90% of visits;

C, recorded at least 3 times, but on fewer than 50% of visits;

D, recorded only once or twice.

Percentages refer to periods during which a particular species is present in coastal Kenya. See text for notes on overflying storks, raptors, waders, swifts etc., which are excluded here. Species which we regard as confined or mainly confined to forest or *Brachystegia* woodland in coastal Kenya are marked with an asterisk.

		1	2	3	4
* <i>Accipiter melanoleucus</i>	Great Sparrow Hawk	—	C	C	—
* <i>Accipiter minullus</i>	Little Sparrow Hawk	C	C	B	C
<i>Accipiter tachiro</i>	African Sparrow Hawk	B	B	C	C
<i>Aviceda cuculoides</i>	Cuckoo Falcon	—	—	C	C
<i>Circaetus cinereus</i>	Brown Snake Eagle	—	—	D	—
* <i>Circaetus fasciolatus</i>	Southern Banded Snake Eagle	B	B	B	C
* <i>Hieraaetus dubius</i>	Ayres' Hawk Eagle	D	—	—	C
<i>Kaupifalco monogrammicus</i>	Lizard Buzzard	B	B	A	C
* <i>Polyboroides radiatus</i>	Harrier Hawk	C	C	C	—
* <i>Stephanoaetus coronatus</i>	Crowned Hawk Eagle	C	C	C	C
<i>Terathopius ecaudatus</i>	Bateleur	C	C	B	C
<i>Coturnix delegorguei</i>	Harlequin Quail	—	—	D	—
<i>Francolinus coqui</i>	Coqui Francolin	—	—	B	—
<i>Francolinus sephaena</i>	Crested Francolin	—	—	D	D
* <i>Guttera pucherani</i>	Kenya Crested Guinea Fowl	C	B	C	B
* <i>Columba delegorguei</i>	Bronze-naped Pigeon	—	D	D	—
<i>Streptopelia capicola</i>	Ring-necked Dove	—	—	A	—
<i>Streptopelia semitorquata</i>	Red-eyed Dove	A	A	A	B
<i>Treron australis</i>	Green Pigeon	—	D	D	D
<i>Turtur chalcospilos</i>	Emerald-spotted Wood Dove	C	B	A	B
<i>Turtur tympanistria</i>	Tambourine Dove	B	A	A	A
<i>Poicephalus cryptoxanthus</i>	Brown-headed Parrot	—	D	D	D
* <i>Tauraco fischeri</i>	Fischer's Turaco	C	C	D	C
<i>Centropus superciliosus</i>	White-browed Coucal	—	—	B	—
<i>Ceuthmochares aereus</i>	Yellow-bill	—	D	D	—
<i>Chrysococcyx caprius</i>	Didric Cuckoo	—	—	—	D
<i>Chrysococcyx klaas</i>	Klaas' Cuckoo	—	—	C	D
<i>Clamator jacobinus</i>	Black and White Cuckoo	—	—	C	—
<i>Cuculus canorus</i>	European Cuckoo	C	C	C	—
<i>Cuculus clamosus</i>	Black Cuckoo	—	—	C	—
<i>Cuculus gularis</i>	African Cuckoo	—	—	C	—
<i>Cuculus poliocephalus</i>	Lesser Cuckoo	C	C	C	—
* <i>Paccycoccyx audeberti</i>	Thick-billed Cuckoo	—	C	C	—
<i>Bubo lacteus</i>	Verreaux's Eagle Owl	D	—	C	—
* <i>Ciccaba woodfordii</i>	African Wood Owl	A	A	A	A
* <i>Glaucidium capense</i>	Barred Owlet	—	C	B	D
* <i>Otus irenae</i>	Sokoke Scops Owl	—	—	D	A
<i>Caprimulgus europaeus</i>	European Nightjar	—	—	D	—
<i>Caprimulgus clarus</i>	Slender-tailed Nightjar	—	—	D	—
* <i>Caprimulgus pectoralis</i>	Fiery-necked Nightjar	B	B	A	A
<i>Apus berliozi</i>	Forbes-Watson's Swift	—	—	D	—
* <i>Neafrapus boehmi</i>	Boehm's Spinetail	C	C	B	C
* <i>Telecanthura ussheri</i>	Mottle-throated Spinetail	C	C	C	C
<i>Colius striatus</i>	Speckled Mousebird	—	—	C	—
* <i>Apaloderma narina</i>	Narina's Trogon	B	B	B	B
<i>Halcyon albiventris</i>	Brown-hooded Kingfisher	—	—	B	—
<i>Halcyon chelicuti</i>	Striped Kingfisher	—	—	B	—
<i>Halcyon senegaloides</i>	Mangrove Kingfisher	—	—	C	—
* <i>Ispidina picta</i>	Pygmy Kingfisher	B	B	B	B

TABLE 1 CONTINUED

		1	2	3	4
<i>Merops albicollis</i>	White-throated Bee-eater	—	—	C	—
<i>Merops pusillus</i>	Little Bee-eater	—	—	D	D
<i>Merops superciliosus</i>	Madagascar Bee-eater	—	—	C	—
* <i>Eurystomus glaucurus</i>	Broad-billed Roller	—	—	A	—
<i>Upupa epops</i>	Hoopoe	—	—	D	—
* <i>Phoeniculus cyanomelas</i>	Scimitarbill	—	—	C	A
<i>Phoeniculus purpureus</i>	Green Wood-Hoopoe	C	C	A	C
* <i>Bycanistes brevis</i>	Silvery-cheeked Hornbill	B	B	B	C
* <i>Bycanistes bucinator</i>	Trumpeter Hornbill	C	C	C	C
* <i>Tockus alboterminatus</i>	Crowned Hornbill	—	—	C	C
* <i>Buccanodon olivaceum</i>	Green Barbet	B	A	A	C
<i>Lybius torquatus</i>	Black-collared Barbet	—	—	B	—
<i>Pogoniulus bilineatus</i>	Golden-rumped Tinkerbird	C	C	C	C
* <i>Pogoniulus simplex</i>	Green Tinkerbird	C	C	C	C
<i>Indicator indicator</i>	Black-throated Honeyguide	C	C	C	C
<i>Indicator minor</i>	Lesser Honeyguide	—	—	C	—
* <i>Indicator narokensis</i>	Jackson's Honeyguide	—	—	C	—
* <i>Indicator variegatus</i>	Scaly-throated Honeyguide	—	—	C	—
* <i>Prodotiscus zambesiae</i>	Eastern Honeyguide	—	—	D	—
* <i>Campepthera abingoni</i>	Golden-tailed Woodpecker	B	B	A	B
* <i>Campepthera cailliautii</i>	Little Spotted Woodpecker	—	C	C	—
<i>Dendropicos fuscescens</i>	Cardinal Woodpecker	—	—	D	—
* <i>Thripias namaquus</i>	Bearded Woodpecker	—	—	C	—
* <i>Smithornis capensis</i>	African Broadbill	B	—	—	—
* <i>Pitta angolensis</i>	African Pitta	C	D	—	D
<i>Mirafrja rufocinnamomea</i>	Flappet Lark	—	—	C	—
* <i>Psalidoprocne pristoptera</i>	Black Rough-wing	—	—	C	—
<i>Dicrurus adsimilis</i>	Drogo	—	—	C	A
<i>Oriolus auratus</i>	African Golden Oriole	—	—	C	B
* <i>Oriolus chlorocephalus</i>	Green-headed Oriole	—	—	D	—
* <i>Oriolus larvatus</i>	Black-headed Oriole	B	B	A	—
<i>Oriolus oriolus</i>	European Golden Oriole	—	—	C	—
<i>Turdoides rubiginosus</i>	Rufous Chatterer	—	—	C	—
<i>Campephaga flava</i>	Black Cuckoo Shrike	C	C	B	C
<i>Andropadus inportunus</i>	Zanzibar Sombre Greenbul	D	C	B	C
<i>Chlorocichla flaviventris</i>	Yellow-bellied Greenbul	A	A	A	A
* <i>Nicator chloris</i>	Nicator	A	A	A	B
* <i>Phyllastrephus debilis</i>	Smaller Yellow-streaked Greenbul	A	A	—	B
* <i>Phyllastrephus fischeri</i>	Fischer's Greenbul	A	A	C	A
<i>Phyllastrephus strepitans</i>	Northern Brownbul	—	—	C	C
* <i>Phyllastrephus terrestris</i>	Brownbul	A	A	C	A
<i>Pycnonotus barbatus</i>	Yellow-vented Bulbul	—	—	C	—
* <i>Cercotrichas quadrivirgata</i>	Eastern Bearded Scrub Robin	A	A	A	A
<i>Cossypha natalensis</i>	Red-capped Robin Chat	A	A	A	A
* <i>Neocossyphus rufus</i>	Red-tailed Ant-Thrush	A	A	B	A
* <i>Sheppardia gunningi</i>	East Coast Akalat	B	—	—	C
* <i>Turdus fischeri</i>	Spotted Ground Thrush	C	C	D	C
* <i>Apalis melanocephala</i>	Black-headed Apalis	A	A	A	A
<i>Canaroptera brachyura</i>	Grey-backed Canaroptera	A	A	A	A
<i>Cisticola brachyptera</i>	Siffling Cisticola	—	—	D	—
* <i>Eremomela scotops</i>	Green-cap Eremomela	—	—	D	—
<i>Phylloscopus trochilus</i>	Willow Warbler	—	—	C	—
<i>Prinia subffava</i>	Tawny-flanked Prinia	—	—	C	—
* <i>Batis mixta</i>	Puff-back Flycatcher	A	A	D	B
* <i>Batis soror</i>	Coast Chin-spot Flycatcher	—	—	D	A
* <i>Erythrocerus holochlorus</i>	Little Yellow Flycatcher	A	A	A	B
<i>Platysteira peltata</i>	Black-throated Wattle-Eye	—	—	C	—
<i>Terpsiphone viridis</i>	Paradise Flycatcher	B	A	C	B
* <i>Trochocercus cyanomelas</i>	Crested Flycatcher	A	B	—	B
* <i>Muscicapa caerulea</i>	Ashy Flycatcher	—	—	C	B
<i>Muscicapa striata</i>	Spotted Flycatcher	—	—	B	—
* <i>Myioparus plumbeus</i>	Grey Tit Flycatcher	—	—	D	—
* <i>Anthus sokokensis</i>	Sokoke Pipit	C	B	C	C
<i>Tmetothylacus tenellus</i>	Golden Pipit	—	—	D	—
<i>Dryoscopus cubla</i>	Zanzibar Puff-Back	A	A	A	B
<i>Laniarius ferrugineus</i>	Tropical Boubou	C	B	B	A

TABLE 1 CONTINUED

		1	2	3	4
<i>Malacoonotus blanchoti</i>	Grey-headed Bush Shrike	—	—	C	—
<i>Malacoonotus sulfureopectus</i>	Sulphur-breasted Bush Shrike	—	—	C	—
<i>Malacoonotus quadricolor</i>	Four-coloured Bush Shrike	—	C	C	B
<i>Tchagra australis</i>	Brown-headed Bush Shrike	—	—	B	—
<i>Tchagra senegala</i>	Black-headed Bush Shrike	—	—	B	—
<i>Lanius collurio</i>	Red-backed Shrike	—	—	C	—
* <i>Prionops retzii</i>	Retz's Red-billed Shrike	—	C	B	—
* <i>Prionops scopifrons</i>	Chestnut-fronted Shrike	B	B	A	C
<i>Cinnyricinclus leugogaster</i>	Violet-backed Starling	—	—	D	—
* <i>Lamprolornis corruscus</i>	Black-bellied Glossy Starling	A	C	A	B
<i>Antherptes collaris</i>	Collared Sunbird	A	A	A	A
* <i>Antherptes pallidigaster</i>	Amani Sunbird	D	C	A	D
* <i>Antherptes reichenowi</i>	Plain-backed Sunbird	C	B	D	C
<i>Nectarinia amethystina</i>	Amethyst Sunbird	—	—	B	—
* <i>Nectarinia olivacea</i>	Olive Sunbird	A	A	A	A
<i>Nectarinia pembae</i>	Violet-breasted Sunbird	—	—	D	—
* <i>Ploceus bicolor</i>	Dark-backed Weaver	A	A	A	D
<i>Ploceus cucullatus</i>	Black-headed Weaver	—	—	C	—
* <i>Ploceus golandi</i>	Clarke's Weaver	C	C	B	C
<i>Ploceus intermedius</i>	Masked Weaver	—	—	D	—
<i>Quelea quelea</i>	Red-billed Quelea	—	—	D	—
<i>Bubalornis niger</i>	Red-billed Buffalo Weaver	—	—	D	—
<i>Estrilda astrild</i>	Common Waxbill	—	—	C	—
<i>Hypargos niveoguttatus</i>	Peter's Twin-spot	C	B	—	B
<i>Lonchura bicolor</i>	Rufous-backed Mannikin	—	—	B	—
<i>Lonchura cucullata</i>	Bronze Mannikin	—	—	D	—
* <i>Mandingoa nitidula</i>	Green Twin-spot	C	C	C	C
Total number of species		64	79	132	70
Total number of 'forest' species		42	49	57	42

TABLE 2

Sokoke Forest census results for each habitat (1-4, defined in Table 1)

	1	2	3	4
<i>Circaetus fasciolatus</i>			(1)	(2)
<i>Erancolinus sephaena</i>				(2)
<i>Guttera pucherani</i>				(1)
<i>Streptopelia semitorquata</i>			(2)	(2)
<i>Turtur chalcospilos</i>			(1)	(1)
<i>Turtur tympanistria</i>	1	2	1(2)	6(2)
<i>Tauraco fischeri</i>				(2)
<i>Centropus superciliosus</i>			(1)	
<i>Chrysococcyx caprius</i>				(1)
<i>Caprimulgus clarus</i>			(1)	
<i>Caprimulgus pectoralis</i>			1	1
<i>Neafrapus boehmi</i>				(2)
<i>Telacanthura ussheri</i>				(1)
<i>Apaloderma narina</i>			(1)	1(3)
<i>Halcyon albiventris</i>			(2)	
<i>Ispidina picta</i>	3		4	(3)
<i>Phoeniculus purpureus</i>			(3)	
<i>Tockus alboterminatus</i>			(2)	
<i>Buccanodon olivaceum</i>			(14)	
<i>Pogoniulus simplex</i>			1	
<i>Indicator indicator</i>			(1)	
<i>Indicator variegatus</i>			(1)	
<i>Campethera abingoni</i>	1			
<i>Thripias namaquus</i>			(1)	
<i>Smithornis capensis</i>	3			
<i>Dicrurus adsimilis</i>			(2)	

TABLE 2 CONTINUED

	1	2	3	4
<i>Oriolus auratus</i>			(6)	
<i>Campephaga flava</i>			3	(2)
<i>Andropadus importunus</i>				1
<i>Chlorocichla flaviventris</i>	5	8	7(2)	2(2)
<i>Nicator chloris</i>	6	6	7(1)	2(3)
<i>Phyllastrephus debilis</i>	9	14		3(5)
<i>Phyllastrephus fischeri</i>	13	6	3(1)	15(6)
<i>Phyllastrephus terrestris</i>	4	3		7(5)
<i>Cercotrichas quadrivirgata</i>	5	7	6(1)	14(1)
<i>Cossypha natalensis</i>	17	17	30(5)	5(27)
<i>Neocossyphus rufus</i>				1(5)
<i>Sheppardia gunningi</i>	4			(3)
<i>Turdus fischeri</i>		1		1(2)
<i>Apalis melanocephala</i>		2		3(4)
<i>Camaroptera brachyura</i>	2	3	8(3)	11(4)
<i>Batis mixta</i>	6	7		4(9)
<i>Batis soror</i>			3(2)	
<i>Platysteira peltata</i>			(1)	
<i>Erythrocerus holochlorus</i>	1	4	1	1(2)
<i>Terpsiphone viridis</i>	1	2	1(5)	(6)
<i>Trochocercus cyanomelas</i>	7	1		3(6)
<i>Muscicapa caerulea</i>		1	(1)	
<i>Anthus sokokensis</i>		2	(2)	
<i>Dryoscopus cubla</i>			1	
<i>Laniarius ferrugineus</i>		2		7
<i>Malacocorypha quadricolor</i>				3
<i>Tchagra australis</i>			1	
<i>Prionops retzii</i>			1(8)	
<i>Prionops scopifrons</i>			5(1)	
<i>Lamprolaima corruscus</i>			(5)	(4)
<i>Anthreptes collaris</i>	1	1	4	1(1)
<i>Anthreptes pallidigaster</i>				(1)
<i>Anthreptes reichenowi</i>	1	3	(1)	1(4)
<i>Nectarinia olivacea</i>	8	8	6(2)	3(8)
<i>Ploceus bicolor</i>			1	
<i>Ploceus gollandi</i>			3	(3)
<i>Hypargos niveoguttatus</i>				4
<i>Mandingoa nitidula</i>	2		2	

Notes: Figures in parenthesis are derived from DAZ's census in 2 ha tracts in July 1966, using the visual, aural and netting techniques described by Zimmerman (1972): 25 man-hours in *Brachystegia* and 40 man-hours in *Cynometra-Manilkara*. Other figures, for all four habitats, refer to PLB's samples of 100 birds ringed in each habitat between April and September (used for calculating indices of diversity in Table 3).

TABLE 3

Species diversity indices and number of species (S) for samples of 100 marked birds in each of the four Sokoke Forest habitats, together with indices for forest habitats elsewhere in Africa.

	1	2	3	4	Sh	Kak	Ls	Lf	As	Af
Index A	0.916	0.915	0.876	0.921	0.863	0.89	—	—	0.894	0.916
Index C	2.70	2.71	2.59	2.80	—	2.81	2.82	3.63	—	—
S	21	21	24	23	17	26	—	—	29	29

Notes: Indices are fully defined in Britton (1978), ranging from 0 to 1 (index A) or 0 to 4.61 (index C) Sokoke forest habitats (1–4) are defined in Table 1; sample compositions are given in Table 2. Other samples included are:

- Shimoni Forest (= Sh), South Kenya coast, 55 birds netted by PLB in July–September;
- Kakamega Forest (= Kak), western Kenya, four samples of 100 birds in Britton (1978);
- Liberia shrub (= Ls, planted in 1965, worked in 1971, canopy height at 9–12 m) and Liberia forest (= Lf), both samples of 100 birds in Karr (1976);
- Amani secondary forest (= As) and virgin forest (Af), calculated from samples of 294 and 231 ringed birds listed by Stuart & Hutton (1977).



TABLE 4  
Composition of ten bird parties along a 1 km transect at Kararacha, 6-10 October 1973.

	Brachystegia			Afzelia		Mixed Brach./Afzelia.	
<i>Phoeniculus cyanomelas</i>	2		1				
<i>Phoeniculus purpureus</i>			2				
<i>Bycanistes brevis</i>							
<i>Buccanodon olivaceum</i>	1	1				1	
<i>Pogoniulus bilineatus</i>				1			
<i>Pogoniulus simplex</i>				2			
<i>Campethera abingoni</i>				1	1		1
<i>Campethera cailliautii</i>	1		1				
<i>Dicrurus adsimilis</i>		2	1				
<i>Oriolus larvatus</i>	1	2	1				
<i>Campephaga flava</i>	2	1	2		1	2	1
<i>Chlorocichla flaviventris</i>	1		1				2
<i>Nicator chloris</i>	2		2	2			2
<i>Phyllastrephus debilis</i>				3	2	1	
<i>Phyllastrephus fischeri</i>					1		1
<i>Phyllastrephus strepitans</i>					1		
<i>Apalis melanocephala</i>	2			3	1	2	1
<i>Camaroptera brachyura</i>			1		1		
<i>Batis mixta</i>	1			1	2	3	1
<i>Batis soror</i>		2	2				
<i>Erythrocercus holochlorus</i>	2				3		3
<i>Terpsiphone viridis</i>					1		1
<i>Trochocercus cyanomelas</i>				1	1		
<i>Prionops retzii</i>			5				8
<i>Prionops scopifrons</i>	22	14	13				
<i>Anthreptes collaris</i>		2	1		1		3
<i>Anthreptes pallidigaster</i>	1		2				1
<i>Anthreptes reichenowi</i>					2		2
<i>Nectarinia olivacea</i>					1		
<i>Ploceus bicolor</i>		2	2	2		2	
<i>Ploceus golandi</i>	8					27	

#### NOTES ON SELECTED SPECIES

##### COLUMBA DELEGORGUEI

Collected by van Someren (1927) in coastal Kenya at Sokoke Forest and Rabai where 'they are not permanently resident, though they visit these areas when a particular tree is heavy in fruit'. This species was not listed by Ripley & Bond (1971) and the only recent records are sightings by H.A. Britton & PLB at Sokoke Forest (single birds on three occasions, once with G.C. Backhurst) and in forest at Shimba Hills (once).

##### OTUS IRENEAE

The type of this distinctive species was obtained in *Brachystegia* woodland in Sokoke Forest at 60 m a.s.l. on 9 April 1965 (Ripley 1966). As far as we are aware all subsequent records of this Sokoke endemic are from *Cynometra-Manilkara* forest, and Snow (1978) is incorrect in saying that it 'occurs in the narrow belt of *Brachystegia* woodland of the Sokoke Forest'. Referring to subsequent specimens, Ripley & Bond (1971) note that birds may be either bright rufous or tawny greyish-brown, and that stomachs contained mostly fragments of medium-sized saltatorial Orthoptera (arboreal leaf-feeding insects likely to occur in vegetation off the ground). Its monotonous tinkerbird-like call is repeated eight times each five seconds (Ripley & Bond 1971, sonagram in van der Weyden 1975), usually as a string of 40-120 notes. It often duets, probably involving two males rather than birds of different sex (van der Weyden *in litt.*). All eight specimens are males.

In an effort to determine the habitat requirements and approximate numbers of this wholly nocturnal owl, PLB has spent numerous nights walking along tracks through *Cynometra-Manilkara* forest, plotting calling birds by obtaining at least two compass bearings on each individual, sometimes using playback of tape-recordings. Repeated visits to peripheral areas of structurally similar *Afzelia* forest have shown that it is apparently confined to *Cynometra-Manilkara* forest with a canopy height of at least 4 m. It is absent from low rainfall areas west of Jilore (see Figure 1), though it occurs west of the forest reserve in more southerly areas of higher rainfall. In suitable *Cynometra-Manilkara* forest it occurs at a consistent density of 7-8 pairs per km<sup>2</sup>; study areas were 2 km<sup>2</sup> of rich forest south of Dida, 1 km<sup>2</sup> of moderately rich forest east of Jilore, and 1 km<sup>2</sup> of forest on the western boundary with a canopy at only 5-6 m. The estimated population of 1300-1500 pairs within the forest reserve is probably minimal since two duetting birds were recorded as a single territory.

Virtually nothing is known of the biology of this rare species. It can be found and seen with relative ease, usually perched at about 3 m above the ground. It seldom allows prolonged observation with artificial light and is difficult to follow for any length of time after dawn. Most calling (and probably most activity) takes place during the two hours after dusk and the two hours before dawn, especially the latter. It usually begins calling by 1900 h, and calls more persistently on moonlit nights and during wet periods. It is best observed in the tallest stands of forest in the south where the understory is less tangled.

#### *APUS BERLIOZI*

Little is known of this recently described species. It appears that the race *bensoni* is a migrant, breeding in summer in the mountains of northwestern Somalia and wintering in coastal Kenya, where it has been collected at Sokoke Forest, Gazi and Kilifi in December and January (Brooke 1969, 1972). On 5 February 1978 H.A. Britton and PLB had excellent views of a loose flock of about twenty birds feeding low in open *Brachystegia* woodland at the southern edge of the nature reserve.

#### *INDICATOR NAROKENSIS*

This species is not listed by Ripley & Bond (1971) despite the specimen evidence mentioned by Friedmann (1968). It is included in *Brachystegia* woodland in Table 1 on the basis of recent sight records by H.A. Britton, PLB and D.J. Pearson (possibly *I. meliphilus* though it is unlikely that both occur).

#### *SMITHORNIS CAPENSIS*

This species is regularly heard in lowland rain forest where PLB has ringed three at one site; one was recaptured at the same site six months after ringing. Sokoke Forest birds are presumably referable to the race *suaelicus* which has been collected in coastal Kenya at Buda Forest, Muhaka Forest and Shimba Hills (Ripley & Heinrich 1969, Clancey 1970). These recent records represent a small northward extension of known range.

#### *PSALIDOPROCNE PRISTOPTERA*

Ripley & Bond (1971) referred three short-winged birds collected in Sokoke Forest on 1 December 1964 to the southern race *holomelaena*. H.A. Britton and PLB had excellent views of birds feeding in open *Brachystegia* woodland on 5 November 1977 (single) and 6 December 1977 (at least four). It can be no more than a migrant or wanderer to Sokoke Forest, though these few dates do not indicate a southern origin.

#### *ANDROPADUS VIRENS*

We have not included the Little Greenbul in the avifauna of Sokoke Forest, though it is listed by Ripley & Bond (1971). It is common in the coastal forests south of Mombasa and might still survive north of Kilifi Creek, but we doubt that it occurs within the forest reserve.

#### *ORIOLUS CHLOROCEPHALUS*

One watched by H.A. Britton and PLB at close range for 10 minutes in *Brachystegia* woodland at Kararacha on 29 January 1978 represents a northward extension of known range from Shimba Hills and Diani Forest (Squire 1976).

#### *SHEPPARDIA GUNNINGI*

The race *sokokensis* is endemic to the coastal forests of East Africa. In Sokoke Forest its song is regularly heard in lowland rain forest where it is apparently resident in small numbers. There are few records from other habitats within the forest reserve, though it was formerly regular, and sometimes numerous, in *Cynometra-Manilkara* forest near Kilifi (Forbes-Watson pers. comm., DAZ). They forage along narrow footpaths and trails in thick undergrowth, coming to the ground for lepidopterous larvae and other invertebrates. In Mozambique, Clancey (1969) reported the nominate race feeding 'in comparatively close association with other edge-feeding robins, such as *Cossypha natalensis* and *Erythropgia (Cercotrichas) quadrivirgata*', but we have never recorded *sokokensis* in mixed bird parties. Both races are somewhat crepuscular. Weights (g) and wing-lengths (mm) of our collected and ringed birds substantiate the claim of Benson (1946) and Clancey (1969) that *sokokensis* is smaller than the nominate race (4 ♀♀, 12–15, 64–66; 2 ♂♂, 13–16, 69.5–70; 3 unsexed, 15.2–18.4, 67–71).

#### *TURDUS FISCHERI*

Britton & Rathbun (1978) have reviewed the status of the nominate race which is endemic to the coastal forests of East Africa, recorded only between late March and late November. Two males collected by DAZ in July 1966 were not included. Both weighed 60 g, wing-lengths 113 and 115 mm; one had seeds and fruit pulp in its stomach.

#### *EREMOMELA SCOTOPS*

It is curious that Ripley & Bond (1971) did not list this species which van Someren (1932) collected at Sokoke and Mongeya (inland from Sokoke Forest). The only subsequent record is a party of at least four watched by H.A. Britton and PLB at close range in *Brachystegia* woodland at the southern end of the nature reserve on 11 June 1978.

#### *MYIOPARUS PLUMBEUS*

Though recorded at Malindi by Jackson (1938) we know of no previous records from Sokoke Forest, where H.A. Britton and PLB have twice seen it in open *Brachystegia* woodland.



*ANTHUS SOKOKENSIS*

This East African endemic occurs in all four vegetation types though it favours uncleared *Azelia* forest, contrary to earlier reports that it is primarily a species of glades and forest edges. When flushed from the ground it usually flies to a high perch, rather in the manner of *Pitta angolensis*. Unless flushed, it is only likely to be located when calling its loud *swee* note, equally likely to be heard from a perch or the ground. Though a threatened species it is unlikely to be as rare as is generally supposed. PLB's still inadequate data indicate a density of as much as 1 pair per 2 ha in *Azelia* forest, giving a population of possibly 2500 pairs in this habitat alone. Thus the total Sokoke Forest population could be as much as 3000-5000 pairs, since it is absent from only the impoverished low rainfall habitats in the northwest.

*ANTHEREPTES PALLIDIGASTER*

Britton & Britton (1978) have estimated the population of this East African endemic as approximately 2900-4700 pairs. In Sokoke Forest it is virtually confined to *Brachystegia* woodland.

*PLOCEUS GOLANDI*

Though endemic to Sokoke Forest this little-known weaver is seldom recorded outside the period August-October when it is usually in flocks with *Prionops scopifrons*, *P. retzii* and other species in *Brachystegia* woodland. Groups usually consist of 5-30 birds, but can exceed 100, sometimes in twittering flocks without other species. The following weights (g) and wing-lengths (mm) of birds ringed by G.C. Backhurst and PLB show that males are significantly larger than females (*t*-test,  $P < 0.001$ ).

Weights: 16 ♂♂, 22.5-27.0, mean 24.57, s.d. 1.42.

16 ♀♀, 20.8-24.6, mean 22.48, s.d. 1.01.

Wings: 16 ♂♂, 73-76, mean 74.50, s.d. 1.03.

16 ♀♀, 70-75, mean 72.19, s.d. 1.56.



Sokoke Scops Owl *Otus Ireneae*

(P.A. Agland)





Spotted Ground Thrush *Turdus f. fischeri*

(D.A. Zimmerman)



Sokoke Pipit *Anthus sokokensis*  
(D.A. Zimmerman)



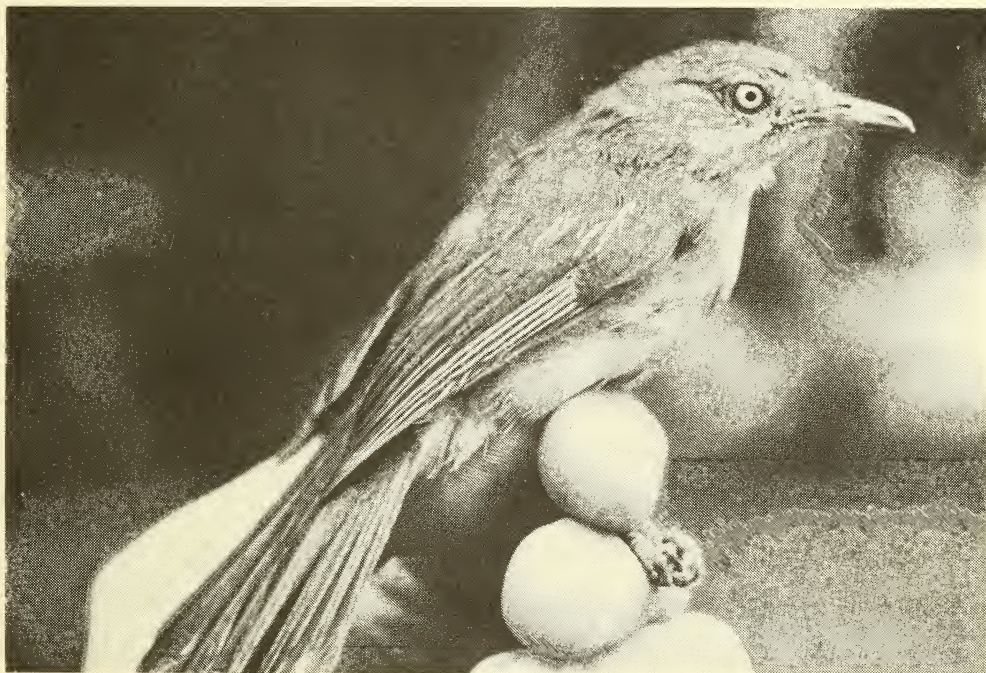
East Coast Akalat *Sheppardia gunningi*  
*sokokensis* (D.A. Zimmerman)



## DISCUSSION

The zoogeography of this and other coastal forests has been discussed by Moreau (1966) and Andrews, Groves & Horne (1975). A southern element is most noticeable in the Sokoke Forest avifauna, though there is a curious blend of influences, including a link with the west and central African forest belt during a moister period, as evidenced by *Neocossyphus rufus*, *Ploceus golandi* (with Weyn's Weaver *P. weynsi*) and *Otus ireneae* (with the Cinnamon Scops Owl *O. icterorhynchus*). Most southern species range north to the gallery forests of the Lower Tana, including Square-tailed Drongo *Dicrurus ludwigii*, Uluguru Violet-backed Sunbird *Anthreptes neglectus* and White-winged Apalis *Apalis chariessa* which do not apparently occur in Sokoke Forest. Others, like *Pogoniulus simplex*, *Eremomela scotops* and *Batis mixta*, range north to Sokoke Forest. *Anthreptes pallidigaster* has a uniquely disjunct distribution at Amani and Sokoke, in two different habitats (Britton & Britton 1978), while *Anthus sokokensis* is confined to coastal forests from Sokoke to Pugu Hills (Mackworth-Praed & Grant 1960).

Even to the casual observer, the coastal forests north and south of Mombasa-Kilifi differ in striking ways, notably the distribution of elephant shrews *Rhynchocyon chrysopygus* (north) and *R. petersi* (south), Black & White Colobus *Colobus angolensis* (south only), and cycads *Encephalartos hildebrandtii* (north) and *Cycas thuarsii* (south). Amongst birds the most notable difference is the abundance of *Andropadus virens* and the absence of endemism in the south. *Oriolus chlorocephalus* and the Barred Long-tailed Cuckoo *Cercococcyx montanus* have been previously recorded only in the south (Britton 1977). though the single record of *O. chlorocephalus* at Kararacha and a freshly dead *C. montanus* under a power-line at Watamu on 30 October 1978 show that these wander north of this Mombasa-Kilifi divide. The Black & White Flycatcher *Bias musicus* has a unique distribution in coastal Kenya, where it is (or was) apparently confined to this divide, at Mombasa, Changanwe, Takaungu and Rabai (Jackson 1938, V.G.L. van Someren egg register). It has not been recorded in coastal Kenya for more than 50 years, though it possibly survives in the Kaya forests of Rabai and Ribe.

Smaller Yellow-streaked Greenbul *Phyllastrephus debilis rabai*

(D.A. Zimmerman)

With 42-57 of its 63 species of 'forest' birds in each habitat, the Sokoke Forest avifauna compares favourably with tropical montane and tropical intermediate forests in Moreau (1966); many more species occur in the tropical lowland forests of west and central Africa (see also Zimmerman 1972, Karr 1976). The little available data on species diversity in the understory of African forests, summarised in Table 3, shows that the avifauna of *Cynometra-Manilkara* forest is as diverse as that of other habitats, excepting primary forest in Liberia. The biomass of birds in the understory of *Cynometra-Manilkara* forest is 13% more than in the structurally similar *Azelia* forest. With the exception of lowland dry forest on coral rag at Shimoni, the understory of *Brachystegia* woodland has the least diverse avifauna in Table 3. Census results for all vegetation strata suggest that *Brachystegia* supports substantially fewer individuals than *Cynometra-Manilkara*, though less time was given to *Brachystegia* (and few birds were caught in nets). First impressions are that *Brachystegia* has a relatively large number of individuals, probably because bird parties in this habitat are more mobile and contain more conspicuous species than parties in forest habitats (see Grieg-Smith 1976, 1978). With 135 birds in 2 ha, *Cynometra-Manilkara* forest compares favourably with Kakamega Forest, where Zimmerman (1972) recorded a mean of 508 birds in 8.1 ha, though the Kakamega Forest avifauna includes far more species.

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